Antibiotic resistance in aquaculture: Novel antimicrobials based on essential oils

SARTER S. and P. DANTHU
CIRAD
UMR-95 Qualisud, URP-Forêt et Biodiversité

Partnership

- Madagascar
  - University of Antananarivo
  - Fofifa (center for rural development)
  - OSO Farming
  - Cirad
- Vietnam
  - Faculty of Fisheries Thu Duc (Ho Chi Minh)
- France
  - Cirad
  - Ifremer

Aquaculture

- One of the fastest growing production sectors in the world
- 50 % in 2015 of the world's food fish
- Intensive use/misuse of antibiotics
- Bacterial resistance (water, sediment, fish bacteria)

Antibiotic resistance

- Absence of the corresponding antibiotic or residus
- Impact extends beyond the individual farm environment
- Resistance system optimisation towards multiple drugs

→ **Multiresistance**

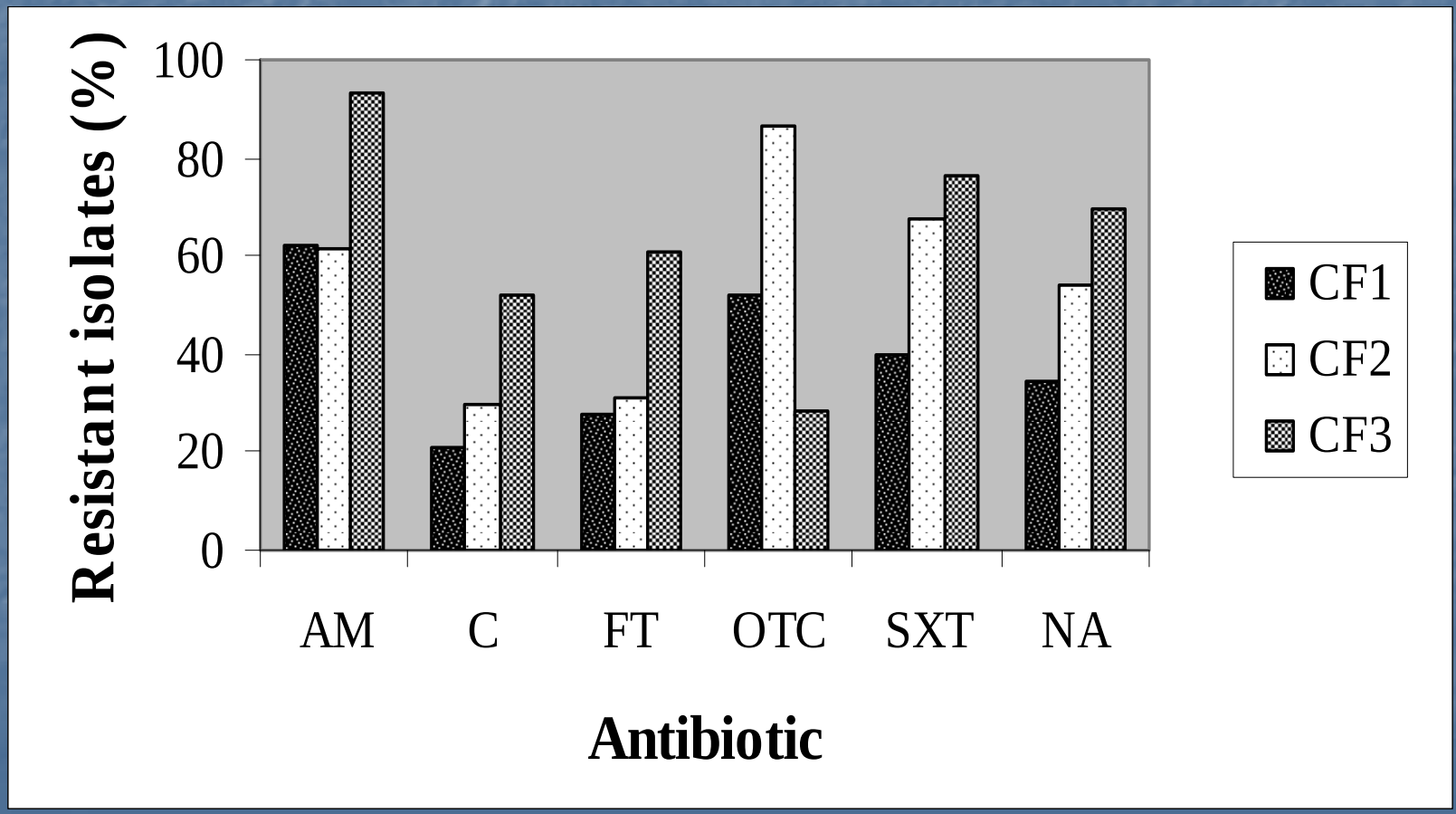
Antibiotic resistance

- Bacterial pathogens resistant to antimicrobial agents:
  - Diseases (vibriosis)
  - Spread of resistance genes to other pathogens of diverse origins
  - Implications on both animal and human health.

Antibiotic resistance

- Use of antibiotics in animals – *Salmonella* sp., *Campylobacter* sp. and *Escherichia coli* –
- Reservoir in non-pathogenic strains
- Horizontal transfer

Sarter et al. Antibiotic resistance in Gram-negative bacteria isolated from farmed catfish. Food control 2007, 18: 1391–1396



Alternatives to antibiotic

- Vaccination (specific immune response)
- Probiotics (*Bacillus* spp.)
- Plant extracts (feed ingredients, *Artemia*)
- Immunostimulants (nonspecific defense systems)

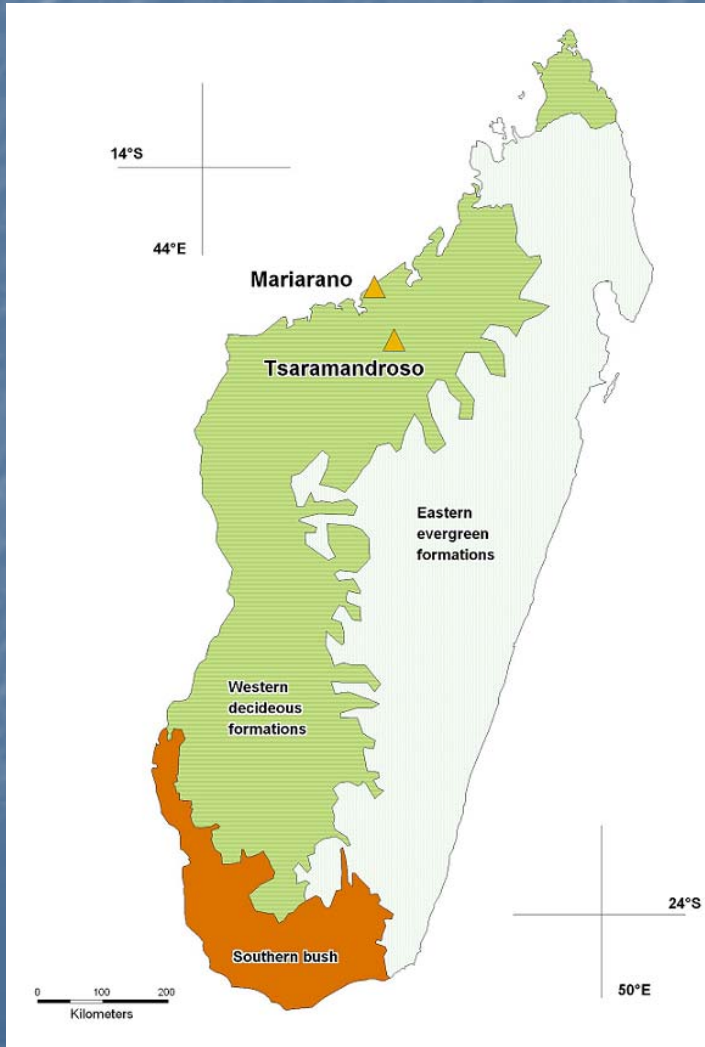
→ **Different biocontrol measures (best management practices)**

Alternatives to antibiotic

- *Cinnamosma fragrans* Baillon
- Family of *Cannelaceae*
- Tsaramandroso and Mariarano
  - Chemical composition
  - Antimicrobial activity
  - Essays in shrimp hatchery

Randrianarivelo et al. Food Chemistry, 2009, 114, 680-684.

- 57 components:
  - Linalool (72.5 ± 23.3 %) in Tsaramandroso
  - 1,8-cineole (47.3 ± 10.2%) in Mariarano.
- B8: 95.8 % of Linalool
- B143: 71.6% of 1,8-Cineole



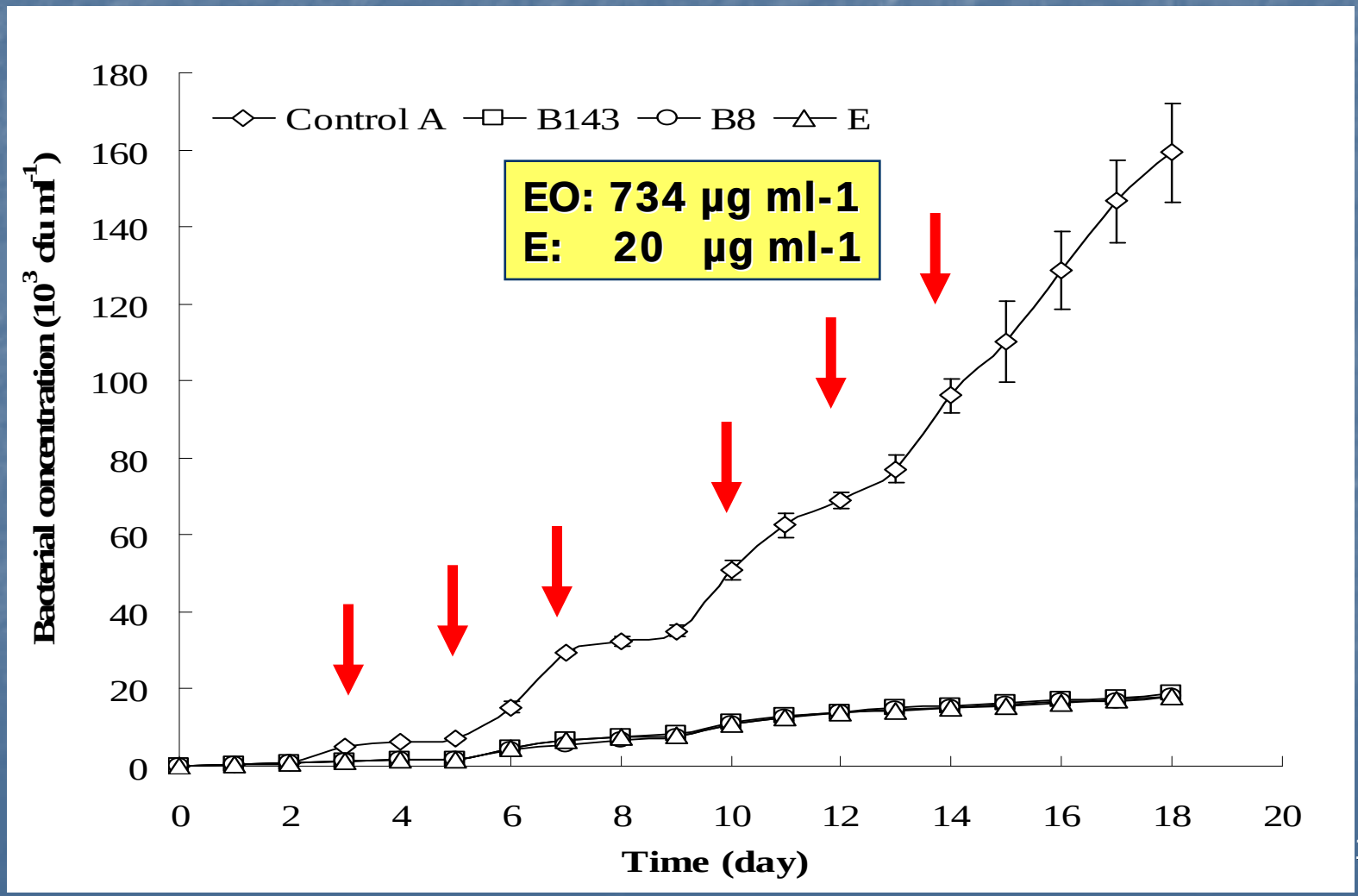
Antimicrobial activity

- Farm isolates
  - *Bacillus subtilis*
  - *Bacillus cereus*
  - *Bacillus pumulus*
  - *Vibrio hollisae*
  - *Vibrio alginolyticus*
  - *V. parahaemolyticus*
  - *Vibrio vulnificus*
  - *P. damselae*
- Reference strains
  - *S. aureus*
  - *S. typhimurium*
  - *Escherichia coli*
  - *Vibrio panaeicidae*
  - *Vibrio fischeri*
  - *Vibrio anguillarum*
  - *Vibrio harveyi*
  - *Vibrio alginolyticus*
  - *Vibrio splendidus*

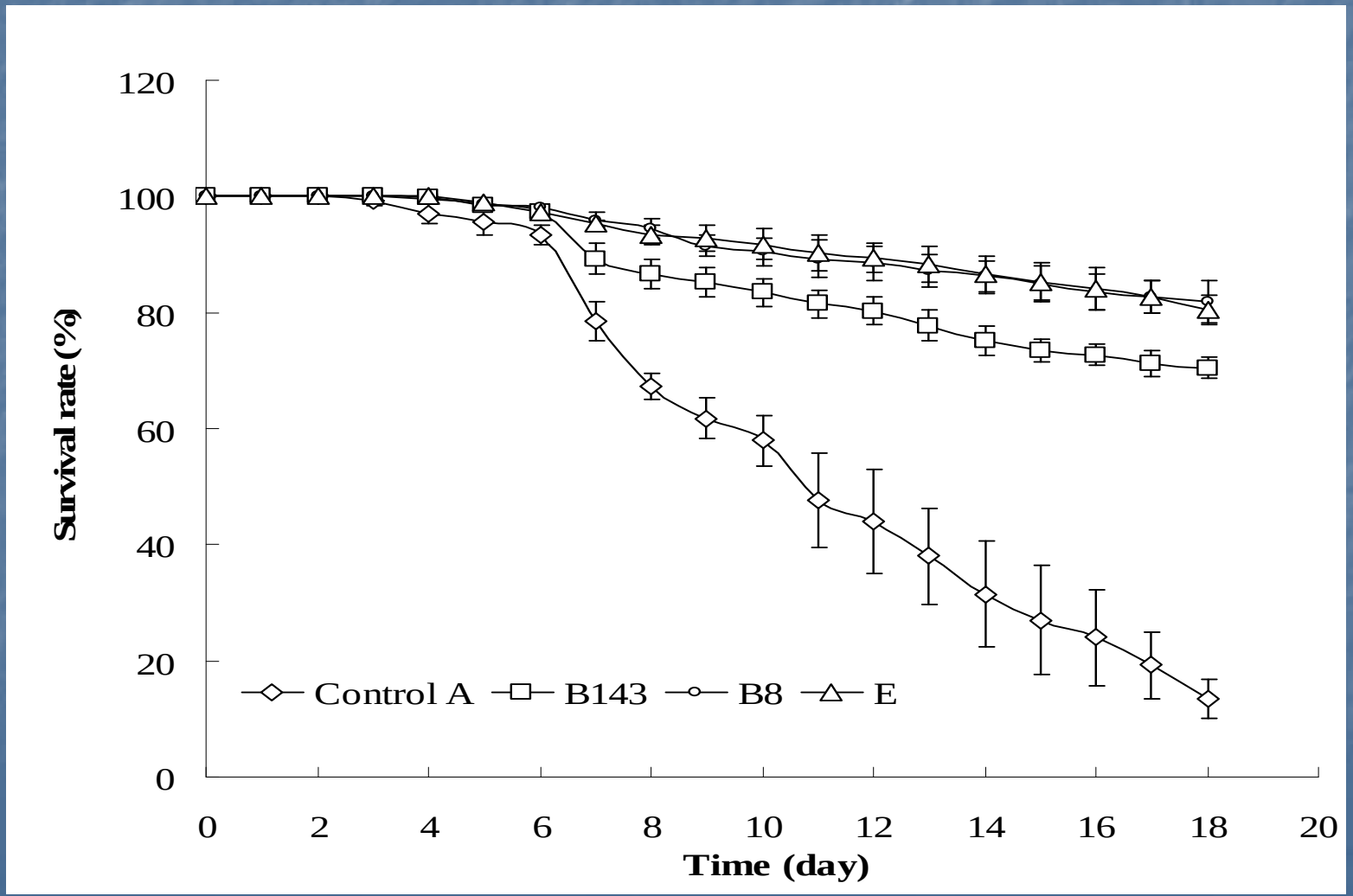
Randrianarivelo et al. Journal of Applied Microbiology, 2010, *in press*

- B8 (95.8% linalool):
  - 0.18-5.88 mg/ml
- B143 (71.6% 1,8-cineole):
  - 0.37-5.88 mg/ml
- Synergy and antagonism

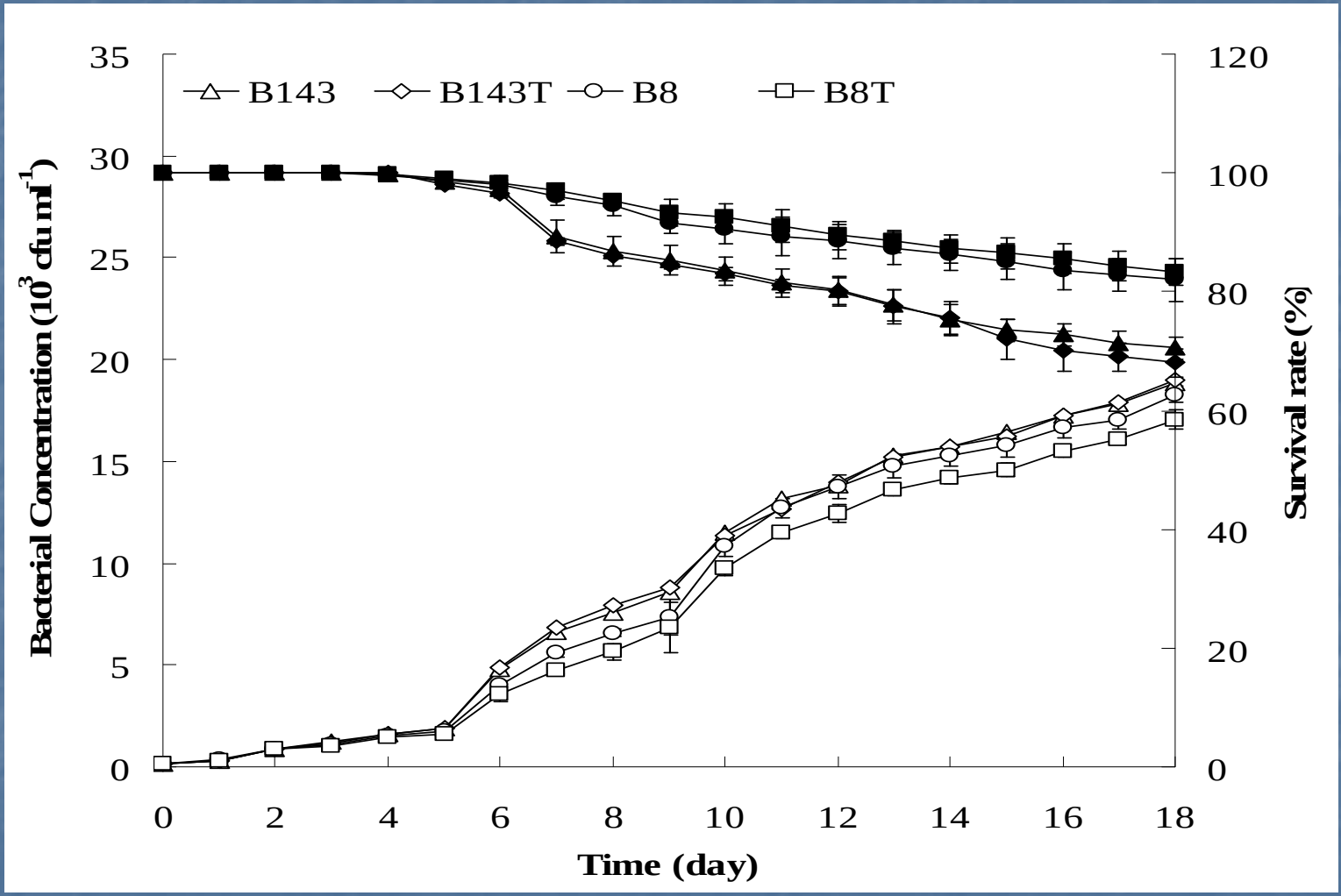
Vibrio concentration (cfu ml^{-1}) of *Penaeus monodon* larvae for assays using EOs of *C.fragrans* and Erythromycin (n=4 ± sd).



Survival rate (%) of *Penaeus monodon* larvae for assays using EOs of *C.fragrans* and Erythromycin (n=4 ± sd).



Vibrio concentration (cfu ml^{-1}) and the survival rate (%) of *Penaeus monodon* larvae.



No significant difference between B8/B8T and B143/B143T ($p>0.05$).

Toxicity

- LC50 on Nauplii, Zoe, Mysis and Post larvae:
  - B8 : 863 mg l^{-1}
  - B143 : 885 mg l^{-1}
  - $p<0.05$

Conclusion

- Low MICs against *Vibrio* spp.
- Decrease vibrios concentration
- Negative correlation between the bacterial concentration and larval survival
- No significant effect of the emulsifier ($p>0.05$)

Conclusion

- Chemical variability
- Compatibility with others alternatives
- Adaptation/resistance mechanisms
- Resistance to diseases